

REMARKS

Claims 1-18 and 22-28 are pending in the application and are rejected. Claims 12-18 and 22-24 are currently amended

Claim Rejections - 35 U.S.C. §103

The following obviousness rejections are asserted:

- (i) Claims 12-18 and 23-28 are rejected as being unpatentable over Brintzinger in view of Dubin, and
- (ii) Claim 22 is rejected as being unpatentable over Brintzinger in view of Dubin and further in view of Jin.

With respect to rejection (i) above, Applicants respectfully submit that at the very least, claims 12 and 23 are patentable and non-obvious over the combination of Brintzinger and Dubin. For example, Applicants submit that the combined teachings of Brintzinger and Dubin do not fairly teach or suggest the subject matters of claims 12 or 23, as a whole, and in particular, a process of forming an interconnection structure including *forming a first solderable layer comprising Cu₂; forming a diffusion barrier layer comprising CoWP over the first solderable layer, and forming a second solderable layer of Ni over the diffusion barrier layer, wherein the Ni layer has a thickness of less than about 4 microns*, as essentially recited in claims 12 and 23.

In formulating the obviousness rejection of claims 12 and 23, the Examiner relies primarily on the teachings of Brintzinger and modified by the teachings of Dubin. In particular, the Examiner cites Brintzinger as disclosing a “first solderable layer” of copper (4) formed over an adhesion layer (3) and a “second solderable layer” of Ni formed over the “first

solderable layer” of copper (4). The Examiner acknowledges that Brintzinger does not disclose a CoWP diffusion layer formed over the “first solderable layer” of copper (4).

Instead, the Examiner relies on Dubin’s teachings (in FIG. 4) of a diffusion barrier (425) formed on a first solderable layer (415) of Cu, wherein the diffusion barrier (425) may be formed of CoWP. The Examiner concludes that it would have been obvious to recognize forming a CoWP diffusion barrier on the copper layer as taught by Dubin. Essentially, the Examiner finds that it would have been obvious to modify the interconnect structure of Brintzinger to include the CoWP diffusion barrier layer as taught by Dubin. Applicants respectfully disagree with the Examiner’s conclusion of obviousness and submit that there is no motivation to combine the teachings of Brintzinger and Dubin in the manner suggested by the Examiner to derive the inventions of claims 12 or 23, for example.

To begin, on a fundamental level, the Examiner’s characterization of the Ni layer (5) in Brintzinger as being a “second solderable layer” is *improper*, as such characterization is undermined by the express teachings of Brintzinger. In particular, Brintzinger specifically teaches that the Nickel layer (5) depicted in FIG. 6 actually serves as a “diffusion barrier” to prevent diffusion of the gold layer (6) into the underlying copper layer (4). In this regard, Brintzinger teaches a stacked structure comprising a copper layer (4), a nickel diffusion barrier layer (5) and a gold layer (6), where the gold layer (6) is actually a “second solderable layer” separated from the first solderable layer of copper (4) by the Nickel diffusion barrier layer (5). Therefore, Brintzinger’s teachings of using Ni as a diffusion barrier actually differs and squarely teaches away from the claimed inventions where Ni serves as a “second solderable layer” formed on a diffusion barrier. Moreover, Brintzinger does not teach or

suggest that the Ni layer (5) has a thickness less than about 4 microns. In fact, in FIG. 4, the Ni layer (5) is much thicker than the copper layer of 2um.

Furthermore, although Dubin discloses in FIG. 4 a diffusion layer (425) (which may be formed of CoWP), Dubin teaches that the diffusion barrier layer (425) is disposed between a Cu layer (415) and an Sn (solder) layer (435). In other words, Dubin does not specifically teach or suggest advantages of using a CoWP layer between Cu and Ni, as in the claimed inventions. In fact, Dubin actually uses the CoWP layer (425) as a second solderable layer, since a solder Sn layer (435) is formed thereon.

In view of the above teachings of Brintzinger and Dubin, Applicants submit that there is no motivation for combining the reference teachings to derive the claimed inventions. For instance, the Examiner's modification of Brintzinger's interconnect structure with the CoWP diffusion barrier layer of Dubin would require that the Nickel diffusion barrier layer (5) in Brintzinger be replaced by a CoWP layer, resulting in a stack of Cu (4), CoWP and gold (6) layers, which in any event does not meet the claimed subject matter. Moreover, this proposed modification of Brintzinger would result in a new interconnect structure that is much different from that which Brintzinger specifically discloses, thus militating against combining the teachings of the cited references.

Moreover, if the Examiner would justify the obviousness finding by modifying Brintzinger with the CoWP layer of Dubin by inserting a CoWP layer between the Cu layer (4) and the Ni layer (5) in the interconnect structure of Brintzinger, this would result in a structure with two different diffusion barrier layers, wherein the inserted CoWP diffusion layer would be disposed between the first solderable copper layer (4) and a diffusion barrier Ni layer (5) in the Brintzinger structure.

In short, the combination of Brintzinger and Dubin does not fairly teach a process of forming a diffusion barrier of CoWP between Cu and Ni solderable layers, as essentially claimed in claims 12 and 23. Accordingly, the combination of Brintzinger and Dubin is legally deficient to establish a prima facie case of obviousness against claims 12 and 23 (as well as claims 13-15, 17, 22 and 24-28, at least by virtue of their dependence). Moreover, in view of the deficiencies of Brintzinger and Dubin as applied to claims 12 and 23, the above obviousness rejection (ii) is also deficient as a matter of law and fact. There is no suggestion in any of the references to use CoWP as a diffusion barrier interposed between Cu and Ni solderable layers of a solder bump interconnection structure. Accordingly, withdrawal of the obviousness rejections is respectfully requested.

Respectfully submitted,

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